

**SAMPLE**  
NOT FOR SALE

# Electric Duet

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## Introduction to The Electric Duet

The Electric Duet is the only music synthesizer program for the Apple ][ that plays two-part music without the need for add-on circuit boards. Two simultaneous musical parts (each with 4 instrument voices) are provided using an advanced digital music generating technique developed for this program. The music may be played through the Apple ][ built-in speaker, or you may connect the Apple to your stereo for room-filling sound. Because The Electric Duet needs no music generating circuit boards, it saves several hundred dollars in extra costs. Here are some of the features, from the simple to the advanced:

- (1) A "jukebox" is provided that allows you to play the provided musical library (or music you have added to the library). This is an excellent introduction to The Electric Duet.
- (2) A piano program is provided that allows you to play two-part music at the Apple ][ keyboard.
- (3) A music editor is provided that allows you to enter music by playing at the Apple ][ keyboard, edit, insert, combine parts, transpose, select instrument voices, and many other things, to simplify music entry.
- (4) After you have created some music, The Electric Duet allows you to include it in a BASIC (or other language) program by creating a portable "player" module that may be placed anywhere in the Apple ][ memory.

Each of these features is explained here. Items of particular importance are printed in boldface.



## Part I. Playing Electric Duets

### Playing the Jukebox

To play some Electric Duets, place the system diskette in your disk drive, and turn the Apple ][ on (on older Apple ][ systems, you may have to follow the directions provided for disk booting). Select menu option [P]lay (the [brackets] around the choices mean for you to press a [letter] key to make your choice.) The program will ask whether you want to play the [P]iano or [J]ukebox. Select [J]ukebox. The program will warn you that the Apple ][ memory will be erased, then will ask that the music diskette be placed in slot 6, drive 1. If you have placed your disk controller in this slot, then you may press return.

Now you may choose one of the musical selections. Move up by pressing [I], down with [M], [P]lay with [P]. To play all the selections in a repeating program, press [X].

The selections are by Bach, Mozart (Sonata), and Scott Joplin (The Entertainer.) The music was entered into The Electric Duet by simply playing them from sheet music, using the Apple ][ keyboard as a piano (to be explained.)

### Playing the music through your stereo

The Electric Duet has excellent sound quality, much better than can be reproduced through the Apple ][ built-in speaker. Here are some ways to improve the quality of the performance:

The simplest way is to use a larger speaker than is provided inside the Apple ][ (no amplifier is needed.) Your local Apple ][ dealer can help you do this.

A better way is to play the music through your stereo or other amplifier. To do this, simply connect the Apple ][ cassette tape output to the amplifier. In most cases, the correct patch cord for this purpose will have a miniature phone plug on one end and an RCA phono plug on the other. Most stereo stores will have this item. When you play music through your stereo, select tape output at the main menu.

## Playing the Electronic Piano

To play some piano music in two voices, go back to the program's Main Menu by pressing [\*] (quit), and select [P]lay again. This time select [P]iano instead of [J]ukebox.

You will see a piano keyboard display, with many of the Apple ][ keys printed on the piano keys. This is to show which Apple ][ key you press to get a piano note. The names of the notes are printed below the keys.

The piano plays two notes, so the keyboard is divided into two sections. The upper row of Apple ][ keys (QWERTYUIOP) plays one note, and the lower row (ZXCVBNM<>/) plays another, of lower pitch.

Now we can play some notes. Press these keys in the order listed:

Line One: R,6,U,I,O,I,U,T,E

Do you recognize "Greensleeves"? The next line is:

Line Two: R,T,6,R,R,E,R,T,E,Q

To finish the melody, play Line One (above) again, then:

Line Three: R,T,6,T,R,4,W,4,R,R

You may press a key in the lower row while playing these notes, for harmony:

Upper Row: R,6,U,I,O,I,U,T,E

Lower Row: M,M,L,L,L,/,,N

Whenever you want to quiet the piano, simply press the space bar.

Here is another melody you may recognize:

O,.,I,Q,T,<,Z

This version of the piano is for familiarization. Later, when you write music with the piano, a different method is used that plays notes over a much wider range.

# Electric Duet

## Part II. Entering Electric Duets

This section describes how to enter music into The Electric Duet for electronic performance. The methods described here were used by the author to create the [J]ukebox selections.

### Use of the Music Editor

Return to the Main Menu by pressing [\*], and select [W]rite. A text editor display will be seen, probably with some music entries on display (because the jukebox uses the same memory area as the text editor.) To erase these entries, press [Z]ap, then [Y]. Now the label "NEW LINE" will appear on the editor line (the inverse line in the middle of the screen.)

You may see all the editor commands listed at the top of the screen by pressing [/] repeatedly. Each of the commands is activated by pressing the corresponding letter key. The use of each of the commands is explained here.

There are two principal music entry methods. One is to type in the notes at the editor. The other, easier method is to play the notes and let them be entered automatically.

First let's make an entry at the editor. Each entry consists of two parts, even if one or both are rests. To move the cursor to the desired entry area (1 or 2), press the ESC key. For this example, make the following entry:

1 ,2A                      1 ,3C

This entry means "play two whole notes, one an A in the second octave, one a C in the third octave".

The leftmost numbers set the duration of the played note. In this example the entry (1) stands for whole notes. Other entries:

2 = half note                      8 = eighth note  
4 = quarter note                      16 = sixteenth note

and so forth, to 64th notes. Each of these can be followed by "." for dotted notes (notes that last 50 percent longer than their notation), as in this example:

4 .,3G#                      1 ,R

In this entry the "#" sign means "sharp", and "R" means rest (no sound.) The durations are also different (one a whole note, one a dotted quarter.) When an entry like this is played, the player always selects the shortest duration.

After you have made your entry, simply press return (or [M]) to move down. Each editor scroll command ([I],[M], RETURN) that is entered processes the editor line and includes it into the file. If there is something wrong with your entry, a bell will ring and an example entry will appear at the top of the screen.

Some common entry errors are:

1. Forgetting the comma when you make your entry.
2. Some notes have no sharps (B,E) and an error will result from trying to enter then with the sharp sign "#".

When you move to the end of the file by pressing [M] or RETURN, the label "NEW LINE" will appear, and a copy of the previous entry will appear on the editor line. This is for convenience, saving time when only one of the entry items needs to be changed. In order for an entry to be accepted, at least one character must have been entered before the next scrolling command.

NOTE: It may be useful to load some of the music provided on the system diskette to see the techniques used. We'll show you how to load music from the disk in a moment.

## **[-] Deleting a File Entry**

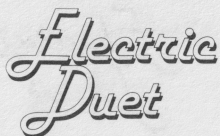
If you have made a mistake in the entry of a line, press [-] to delete that line. This will only work if the edit line (inverse) is at the end of the file (See [O]pen below to delete or insert into the middle of a file.)

## **Direct Numeric Entry**

If you want to create "custom" notes or durations, simply enter them as numbers. Here is an example that plays a long, mysterious-sounding note, that results from "heterodyning" one voice against another:

1 ,1A                      1 ,254

This number-entry method is frequently used in the music library selections for special effects.



## Playing a Text Editor File

To play the notes in the editor file, press [P]lay. You will be asked whether you want to play [A]ll the notes or a range of line numbers. If you press RETURN (sometimes called [CR] for carriage return), the single note on the editor line will be played (unless it is a "NEW LINE"). If you enter a range of line numbers, that range will be played. For tracing purposes, the line number being played is shown at the top of the display.

NOTE: Music played using [P]lay won't sound the same as when played using the [J]ukebox. There will be more pops between notes, and very short notes may not have the correct durations, because more processing time is used between notes in the editor. The best and most accurate performance is always given by the jukebox.

## Music Entry with the Piano

If you select [P]iano (from the [P]lay options) you will be able to play notes and they will be entered into the editor file automatically. From the editor display, press [P] twice.

A combination display will appear, part text editor, part piano. Most of the editor command keys are now musical notes, so you may not use most of the editor commands without first pressing [\*] quit.

To move up, you must now press ConTRoL-[I]. This means to press the key marked "CTRL" and, while holding it down, press "I". To move down, press ConTRoL-M or RETURN.

The normal way to use the [P]iano for music entry is to select the part with the most (or shortest-duration) notes, play that, then switch to the other entry column and play the (relatively simple) accompaniment. Here is an example:

1. Return to the editor by pressing [\*] quit (if you are in the editor [P]iano mode.)
2. Erase all editor entries by pressing [Z] followed by [Y].
3. Go to the editor [P]iano by pressing [P] twice.
4. Select a keyboard range by pressing [A] until the leftmost piano key ("Z" at the top left of the display) has a "2" below it. This selects the octave and is optional, but sounds well through the Apple ][ built-in speaker.

# Electric Duet

5. Play the following keys. Between each note, press RETURN to advance through the file:

Melody Line: R,6,U,I,O,I,U,T,E

NOTE: If you play a wrong note, don't worry. The note isn't accepted until RETURN is pressed. If RETURN was pressed by mistake, simply press ContROl I to move up, then play the note again.

You will notice that the voice on the right has "R" as a note for each entry. This stands for rest (no sound.)

6. Now scroll back up to the beginning of the notes using ContROl I. You will notice that each note is played as it enters the (inverse) editor line.

7. Switch entry sides by pressing the key marked "ESC". The cursor will now appear at the right (if you've been following the example exactly. You can press "ESC" again to move the cursor back, if necessary.)

8. Now play the accompaniment. The first note (note 0) doesn't get an accompanying note, so press RETURN, then play the first accompanying note at line 1:

Accompanying Line: M,M,L,L,L,/,/,N

9. Now return to the editor by pressing [\*] (quit.)

The note entries should look like this:

0	8 ,3G	8 ,R
1	8 ,4A#	8 ,2G
2	8 ,4C	8 ,2G
3	8 ,4D	8 ,3A#
4	8 ,4E	8 ,3A#
5	8 ,4D	8 ,3A#
6	8 ,4C	8 ,3C
7	8 ,4A	8 ,3C
8	8 ,3F	8 ,2F

Now play them using [P]. You will notice that the notes are right, but the timing is wrong. The actual notes are not all the same duration. We need to change some of them using the editor. Note durations may be changed by re-tying the correct durations. You may also type ContROl-[R] To shorten or ContROl-[F] to lengthen the duration. Each ContROl character will increase or decrease the note duration by 50 percent. These commands are easy to remember. ContROl-[F] moves FORWARD in the duration table selecting shorter durations, and ContROl-[R] moves in REVERSE, selecting longer durations. Use these commands to change the file

# Electric Duet

like this:

0	8	,3G	8	,R
1	4	,4A#	4	,2G
2	8	,4C	8	,2G
3	4	,4D	4	,3A#
4	16	,4F	16	,3A#
5	16	,4D	16	,3A#
6	4	,4C	4	,3C
7	8	,4A	8	,3C
8	4	,3F	4	,2F

When you are making durations shorter, you need only enter one of the durations for both to be changed. This is because both notes share the same duration value, and the shortest entry is always selected. When you are making durations longer, both must be entered.

NOTE: Avoid using the upper half of the 5th octave in music entries. Some of the notes in this range are not accurate and should be used only for special effects.

## [S]aving a File

After you have entered and edited the previous example "Greensleeves", you may save it for future use. Press [S] for save, and enter a file name (Greensleeves should do) and, if you have more than one disk drive, a slot and drive for the file. You are permitted to put line numbers after the file name, to save a specific part of a file. These numbers are optional. For example:

GREENSLEEVES/0/8/

will save the file beginning at line 0 and ending at line 8.

NOTE: When you save a file using [S], or load using [L] (see below), the prefix "M." is automatically added to the file name. This identifies the file as music so (among other things) the jukebox can pick it out for playing.

## [T]ransposition

The [T]ranspose command is one of the most powerful editor commands. With it, you can speed up or slow down all or part of a musical file, change the key in which it is played, and do special kinds of editing.

In this example, we will speed up our short "Greensleeves" file (since the example entries deliberately made it too slow), then change its key.

# *Electric Duet*

Each entry to [T]ranspose includes a starting line number, an ending line number, a specifier telling [T]ranspose which part of the entry to change (Note 1 or 2 or Duration), and a number telling how far to move. Press [T], then make this entry:

(T)ranspose : /0/8/D1/2/

(press RETURN after the entry)

NOTE: Remember that both notes use the same duration value, so it doesn't matter whether you enter "D1" or "D2", both durations will change.

If you have made the entry correctly, the durations will change, and (when played using [P],[A]) "Greensleeves" will play twice as fast.

Now press [T] and make this entry:

[T]ranspose : /0/8/N1/2/

Then:

[T]ranspose : /0/8/N2/2/

NOTE: Unlike Duration entries, Note entries are independent, and two may be needed as in this example.

NOTE: You may use parts of a previous Transpose entry by pressing the right arrow key and moving the cursor over those characters that are still OK.

Now "Greensleeves" will play one whole step higher in pitch.

Negative numbers may be entered to [T]ranspose:

[T]ranspose : /0/8/N1/-4/

When using [T]ranspose, a change number of 1 will change durations by 50 percent (quarter notes become dotted eighths), and will change notes by a half-step (G becomes G#). A change number of 2 will make durations half or (when -2 is used) twice as long. A change number of 12 will change notes by 1 octave (since there are 12 semitones in an octave).

# Electric Duet

One of the most important uses for [T]ranspose is to improve the sound of an entered piece. While entering music, you may find that some of the notes are too high (or too low) for best Electric Duet performance, or are out of tune (in the 5th octave). Don't get discouraged. Just enter the entire piece, then use [T]ranspose to move the music to a more suitable key. Also remember that music always sounds much better played at the jukebox than from the editor.

Finally, it is best to enter fast music using slow duration values. This makes it easier to detect errors. Then, when the piece is finished, it may be speeded up to the correct tempo.

NOTE: An attempt to [T]ranspose a duration or note out of the available range of these values will leave the value unchanged. For example, [T]ransposing a note of "1A" downward will have no effect. Also, numeric entries (entries other than defined notes and durations) are not transposed. If an attempt to transpose a numeric entry is made, the bell will beep, letting you know an error has occurred. See the Program Value List below.

## [O]pening the File

You may [-] delete or insert lines (or insert disk files using [L]oad) into the middle of your memory file, but first you must [O]pen the file. Here is an example:

You want to delete file line 4. The [-] delete command will only delete the last line of the file, so we must [O]pen the file so that line 4 is the last line. Move the edit line (inverse) to line 5, then press [O]. A prompt will appear:

[O]pen : File is now closed.  
Do you want it open [Y] or [N] ?

Press [Y]. Now Line 4 will appear to be the last line in the file. Delete it using [-], then press [O] again.

[O]pen : File is now open.  
Do you want it closed [Y] or [N] ?

Press [Y]. Line 4 has been deleted, and the file has been combined around it. A file can be [O]pened at only one location at a time for insertions or deletions, it then should be closed again.

This feature can be used to insert new lines into the middle of a file as well as delete them, also disk files may be [L]oaded at the [O]pen point as if it were the end of the file.

### **[L]oad a File**

File name entries to [L]oad are the same as for [S]ave. [L]oad always loads a disk file to the end of the file in memory. To Load a file so that it is the only file in memory, use [Z]ap first to erase previous contents, then [L]oad the new file.

To insert a file at (for example) line 100, use this method:

1. Place the edit line (inverse) at line 101.
2. [O]pen the file (see above). The last line will now be line 100.
3. [L]oad the desired file.
4. Use [O]pen again to close the file around the insertion.

### **[N]otetrace**

To play each note as it is scrolled from the editor (as the [P]iano does), press [N] followed by [Y]. To turn off the [N]otetrace feature, press [N] followed by [N].

### **[H]op To a File Line**

To [H]op to a file line in a long file (where scrolling would be too slow), press [H] and enter the line number you want to go to. If you want to go to the beginning, press [B], to go to the end, press [E].

### **[X] DOS Commands**

DOS commands may be entered by pressing [X] followed by the command (CATALOG, DELETE, etc.). To quit the feature, press RETURN twice with no entry.

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### Part III. Advanced Electric Duets

#### [V]oice Selection

Each note played by The Electric Duet may have one of four (or six, if you are willing to experiment) selected voices. This feature greatly increases the tonal variety of the music (as is demonstrated in the jukebox selections.) Here is an example.

Using the editor, first [Z]ap any file contents, then [L]oad our demonstration file "Greensleeves". The display should look like this:

0	8	,3G	8	,R
1	4	,4A#	4	,2G
2	8	,4C	8	,2G
3	4	,4D	4	,3A#
4	16	,4F	16	,3A#
5	16	,4D	16	,3A#
6	4	,4C	4	,3C
7	8	,4A	8	,3C
8	4	,3F	4	,2F

Now [O]pen the file at line 3, using the methods described above. Now enter the following line:

```
4          V ,003          V ,003
```

NOTE: This is how the line will be displayed after entry. It is not necessary to enter the leading zeros shown here.

Now close the file again using [O]pen. The file should look like this:

0	8	,3G	8	,R
1	4	,4A#	4	,2G
2	8	,4C	8	,2G
3	4	,4D	4	,3A#
4	V	,003	V	,003
5	16	,4F	16	,3A#
6	16	,4D	16	,3A#
7	4	,4C	4	,3C
8	8	,4A	8	,3C
9	4	,3F	4	,2F

[P]lay this file to see the effect. Change the [V]oice numbers for different effects, in the range 1-6 (1-4 are normally used).

The [V]oice commands in line 4 affect all the notes after them. Their effect can only be changed by another [V]oice command line.

It is not necessary that both [V]oice entries be the same number, but both entries in a [V]oice line must be [V]oice entries. This example won't work:

```
4          V ,003          4 ,3A
```

See below for a discussion of [V]oice as it is related to the music generation method.

### The Phantom Octave

It is possible to get a low 6th octave by entering a [V]oice number of 8 before the note to played in this octave. Enter and [P]lay this example:

```
0          1 ,1C          1 ,1E
1          V ,008          V ,008
2          1 ,1C          1 ,1E
```

This example plays such a low pitch that the Apple [[ built-in speaker won't really let you know what's going on. An outside speaker is recommended.

### Using the Program Value List

Interesting effects can be had by "heterodyning" one voice against the other, as is done frequently in the jukebox selections. In order to do this, you need to know the numeric value for each note, then select a number for the other note only one or two counts away.

Also such musical effects as accelerando and decelerando require knowledge of the duration numbers, so a smooth transition can be made from one duration to another (see the end of the "JESU JOY" file for an example).

The Program Value List displays all the note and duration numbers used by The Electric Duet. To display the list, select Main Menu option [M]iscellaneous, then press [L]ist.

You will notice that there are two durations beyond "64" in the duration numbers. These numbers, "99." and "99", are for dotted and normal 128th notes. They are quite difficult to use because of their short duration, but are suitable for experimentation.

# *Electric Duet*

## **File Length, Available Memory**

Music files are saved as DOS 3.3 binary files. The file length is (the last line number plus 2) times 3. Here are some system sizes and capacities:

System	Lines Accepted
32K	4266
48K	9728
48K W/Language Card	12970

NOTE: It is possible to wipe out a file by loading a file segment that is too long for available memory. Always save copies of your work so that you are protected against file loss.

## **Playing The Electric Duet from BASIC**

To play The Electric Duet from your BASIC program, you need a copy of the "player" algorithm, and the binary music file. Here is the procedure.

1. Use the Main Menu option [M]iscellaneous, then select [G]enerate. Place your BASIC diskette in the drive, select an address at which the player will run, then enter a file name. The player will be saved.

The player normally runs in Apple ][ "Page 3" between address locations 768 and 976. It can, however, be placed and run at any available space this size, at address multiples of 256. For most purposes, the "page 300" location is fine.

2. Move the music to your BASIC disk. The DOS 3.3 Master Diskette program "FID" may be used to transfer the file, or the music editor can be used.

3. Write your program, including lines like the following to load the player and music. Assume for this example that you have called the player "PLAYER".

```
10 D$ = CHR$(132)
20 PRINT D$; "BLOAD PLAYER, A768"
30 PRINT D$; "BLOAD M.FILENAME, A24576"
```

(Note: The music address of 24576 is an example. Any available address may be used.)

```
200 REM TELL PLAYER WHERE MUSIC IS
210 POKE 30, 0 : REM 24576 MOD 256
220 POKE 31, 96 : REM 24576 / 256
230 REM NOW PLAY IT
240 CALL 768
```

## **Technical Data**

The Electric Duet is the result of a three-year algorithm development task. The task began in 1978 with "Musicomp", a program presently being sold by Apple Inc. "Musicomp" plays with one voice.

Since that time, a number of music synthesizers, each requiring extra circuit cards and costing several hundred dollars, have appeared in the marketplace.

It has been the author's view that a computer owner shouldn't have to buy expensive add-ons in order to use a program. Therefore it was decided that a two-voice synthesizer should use only Apple ][ features.

The Apple ][ speaker (and tape) output is a digital device (on or off). It isn't possible to control the voltage incrementally. This makes the two-voice task difficult.

# *Electric Duet*

The solution was to create a high-frequency carrier frequency (14,080 Hz) and control the percentage of time it is turned on. This is called "duty-cycle modulation". In this method, the carrier waveform is turned on a percentage of time based on whether one or the other of the musical note cycles is "on" at the moment. This effectively transmits voltage increments to the speaker or amplifier.

Note 1	Note 2	Speaker Duty Cycle
OFF	OFF	0
OFF	ON	50
ON	OFF	50
ON	ON	90

The described increments are controlled by counters containing numbers between 8 and 256. The carrier frequency of 14,080 Hz was selected for its musical importance:

$$14,080 / 32 = 440 \text{ (middle A)}$$

Therefore a pitch number of 32 gives A440.

Another refinement was "voicing", to increase the tonal range of the music. This is also accomplished by duty-cycle modulation, but at a much lower frequency. If a voice of 1 is selected, the generated musical tone has a duty cycle of 50 percent, voice 2 has 25 percent and so forth. If a voice number of 8 or greater is selected, the tone drops an octave in pitch, creating a "phantom octave" for a total of 6 octaves (5 1/2 of which are usable for normal music).

The carrier frequency may be audible in some circumstances, although it is out of the hearing range of most of the population. When an amplifier is used, excessive stereo treble settings may bring it out.

### **Music File Internal Format**

Each file entry consists of three bytes:

Byte 1 = duration. Normal range 2 - 255.

If Byte 1 = 0, it marks the file end.

If Byte 1 = 1, this indicates that bytes 2 and 3 are voice rather than note specifiers. Bytes 2 and 3 both must be note or voice specifiers.

Bytes 2 and 3 = note values for notes 1 and 2

Normal range of values 1 - 255.

If Byte 2 or 3 = 0, a rest is "played".

